INSTRUCTIONS IN AVIATION FOR BEGINNERS

— BY —

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INTRODUCTION

With the aeroplane of the present day speedy travel is possible with a high degree of safety.

The risks taken by the average drivers of automobiles, motorcycles and speed boats travelling at 50 m. p. h. are in many cases greater than those taken by an aviator travelling at the same or even higher speeds; firstly, because the average automobile or motorcycle owner is not in the habit of travelling at these speeds, and secondly, because the surface and bends of the average road combined with the effects of traffic and "skiddy" surfaces positively forbid such a speed being held continuously.

In the case of the speed boat the risks are about the same in rough weather. Except in the case of the aviator, the average driver can gradually work up to the 50 m. p. h. gait with the aid of his skill and general experience. If he is unlucky or clumsy his new experience may come to be expensive.

In the case of the aeroplane the same general points hold good with the exception that the would-be aviator must thoroughly acquaint himself with nature of the atmosphere and the new processes of "starting", flying and landing before undertaking his first flight alone. These are new sensations which must be acquired by experience. The science of flight is similar to the science of electricity, for it depends upon the knowledge of the laws governing an invisible fluid and these laws must be absolutely adhered to. The poorly instructed electrical engineer runs equal risks of accident with the uninstructed flier who plunges into an unexplored element with which he has neglected to acquaint himself.

For these reasons it is absolutely necessary that the embryonic aviator should be instructed both technically and practically.

The following pages contain briefly and in a general way what every aviator must know, but by no means form a complete treatise on the science of aviation, but rather a series of beacons pointing out the way and giving the necessary warnings.

By the Author.

THE AEROPLANE

The essential parts of the aeroplane are:

1. The undercarriage or running gear
2. The fuselage or nacelle
3. The planes
4. The power plant
5. The controls

1. The function of the running gear is to support the weight of the aeroplane, fuel and passengers and to enable this total mass to attain its flying speed on the ground before rising into the air and to reduce the shock when landing. As an aeroplane has to rise from and land on very rough ground, this part of the mechanism is subjected to severe strains, for instance when beginners are making their practice flights and make poor landings. The most common strains are produced by

A. Slowing down the aeroplane too much before reaching the ground, thereby losing too much sustentation and eventually dropping the last few feet to earth.

B. Landing in a sideways direction, that is, not having the centre line of the fuselage in the line of flight, which has the effect of rolling the tires off the wheels and buckling the latter; in exaggerated cases the running gear is damaged in part or in total.

C. Landing across wind which has the same effect as in (B), during which process the lee wing is thrown against the ground and the windward wing blown up, with the result that the machine pivots about the low wing and the rest of the machine swings about this point, culminating in a serious wreck. Landing "across wind" must always be avoided.

D. Landing "down wind" which throws no excessive strain on the running gear, but should be avoided in gusty winds and where there is not ample space in which to pull up.

E. Landing at too steep an angle with the ground. This has the effect of throwing the machine into the air again or even turning it completely over onto its back. The strains in both cases may be severe and result generally in damage.

F. Landing against the wind the strains are the absolute minimum, and therefore landings should always be made in this way.

2. The fuselage or nacelle serves as a foundation for the power plant and carries the accupants, control levers and instruments and forms an integral part with the running gear; in it is concentrated the greatest part of the load.

The rear end of the fuselage carries the elevator and rudder and generally a tail skid, which serves as a support when the machine is at rest.

In the case of the nacelle the elevator and rudder are carried on outriggers. In event of heavy landings the members and joints of the fuselage may become crippled or the engine and fuel tanks may be loosened on their beds.

3. The planes are attached rigidly to the fuselage and carry the total weight during flight. Their function is to produce an upward pressure during normal flight equal to the total load. Should this pressure decrease for any reason the aeroplane will descend and vice versa.

During normal flight in still weather the strain on the planes and bracing is a minimum. While making very sharp turns, steep dives especially, or any sudden evolution or flying in very gusty weather, the strains may be as high as 10 times those during normal flight. It must be realized that such strains are transmitted in the same proportion to every part of the planes, their bracing and the fuselage.

4. The motor, propeller and fuel tanks constitute the life of the aeroplane and the aviator depends upon their perfect cooperation for sustained flight. In the modern aeroplane the motor develops from 25% to 50% more power than is actually necessary for normal flight. This excess of power is provided for rising from rough ground or water, for flying against strong head winds and for rapid climbing, and allows the motor to run throttled during normal flight which has the further advantage of economizing fuel and prolonging the life of the motor.

The propeller is virtually a rotating plane and depends for its satisfactory performance on being perfectly balanced. Generally it is direct coupled to the crankshaft of the motor.

5. The controls serve to steer the aeroplane on the ground and during flight. The area and angular movements of the controlling surfaces are amply large to meet any emergency and consequently when flying under average conditions only small movements of these are necessary to produce the desired results.

INSPECTION

In connection with the aeroplane this forms an integral part of the aviator's training.

There is not a single example of a swiftly moving vehicle which is not rigorously and regularly inspected by those who are responsible for its performance.

The most familiar examples are the locomotive engineer, the chief engineer of any ocean going craft, the automobile racer, the engineer of the central power station, etc., etc. All these men know positively that their machine is RIGHT before they give the word to start.

The same vigilance is required of the aviator. In order to fly in peace and comfort he MUST KNOW that his aeroplane and motor are in perfect order and will remain so until the flight is finished. The duration of a flight should be reckoned as a full working day of 8 hours. With a genuine confidence in his machine the aviator can spend all his time when once in the air in piloting the craft and picking out the best course. Inspection should be done leisurely and not hurried.

The best aviators NEVER take anything for granted; they look over every single item of their aeroplane personally and thus create a well founded confidence.

Mechanicians are not always infallible and absolute reliance should not be placed in them, however trustworthy they may be. On the other hand any advice which they might tender should be carefully weighed before being rejected.

When an aviator knows his machine thoroughly, he will gradually discover that there are a large number of parts which seldom require attention and which may be passed over quickly. Every machine has more or less idiosyncrasies of its own and these become in time familiar to the aviator.

It is difficult to state definitely what portions must be inspected. The object of inspection is solely for the purpose of knowing whether any parts of the aeroplane have become unreliable or dangerous.

The most important questions which an aviator should ask himself before a flight are the following:

Are all nuts and turnbuckles tight and locked?

Are all nuts holding the maximum length of thread?

Is the length of thread engaged in the turnbuckle equal to twice the diamcter?

Is the tension of the wiring right?
Are there any crippled metal or wooden members?
Are there any "frayed" cables?
Is the fabric tight, intact and in sound condition?
Are there any broken ribs or wing spars?
Are any members bent or bowed through some wires being too short and overstressed?
Are the planes, elevator and ailerons in alignment?
Is everything locked which needs this precaution?
Are the gasoline, oil and water connections tight?
Is the radiator full of water?
Is the oil tank and crank case filled with oil?
Is the gasoline tank full?
Do the controls work their appointed directions? Do they work easily and freely?
Are the throttle lever and short circuiting switch in proper working order?
Is the engine firing regularly and running up to normal speed?
Is the propeller in balance?
Are the starting and landing grounds large enough and are they safe?
Am I inwardly calm? If not, I must become so before attempting the flight.

TRAINING

The layman's idea of the word training is confined to the practice necessary to learn how to start, operate and land an aeroplane in approved style.

While it is true that this process is a part of the training, it is of relatively minor importance and can be acquired in from 200 to 300 minutes of flying practice according to the ability of the pupil; and here it may be added that slow learner very often makes the soundest and safest flyer. The flying practice is done under the guidance of a qualified and licensed aviator.

The most vital part of the training consists of acquiring the following habits:

Estimating horizontal and vertical distances and heights of objects.
Estimating the length of run required over different kinds of ground.
Recognizing the nature of objects as seen from above.

Observing weather signs and weather conditions and their effect upon flight.

Observing the conditions set up by wind blowing over nature's obstacles.

Avoiding localities where it is known that dangerous air currents exist.

Observing the effects of sun, earth, water, vegetation and clouds on air structure.

In fact the aviator must get right back to nature.

While the above list may seem formidable at first sight, the average person can sift out from his past experience material upon which to build his aeronautical experience.

The most difficult lesson for most fliers is to learn to keep themselves within the limits of their personal experience, and further, to be callous to the opinions and criticisms of the public which knows little or nothing about their business and should therefore be ignored in a polite way.

LAWS GOVERNING FLIGHT

The lifting power of an aerofoil (plane) is determined by its shape, the angle of incidence or angle at which it passes through the air and its speed through the air.

For example, if the normal flight speed of an aeroplane is 50 m. p. h. in still air, it follows that should this machine fly with a 40 m. p. h. wind, its speed relative to the earth is 90 m. p. h. If flying against this wind, its speed would only be 10 m. p. h relative to the earth. Whatever point of view is taken, the aeroplane must be "splitting" air at 50 m. p. h. in order to support itself.

If the speed of an aerofoil remains constant, then the lifting power increases roughly in direct proportion to the increase of the angle of incidence within the range of angles from 0 degrees to 9 degrees.

For example, if an aerofoil lifts 800 lbs. at a speed of 50 m. p. h. and an angle of incidence of 6 degrees, then at the same speed and an angle of incidence of 9 degrees it will lift roughly

$$800x9/6=1200 \text{ lbs approximately.}$$

The power required to lift this extra weight will be somewhat greater than 9/6 times that required to lift 800 lbs. at 6 degrees.

Further, if the angle of incidence remains constant and the speed increases, then the lifting power increases with the square of the speed.

For example, if the speed of the above aerofoil is increased to 60 m. p. h. it will lift approximately

$$800x60^2/50^2=800x3600/2500=1152 \text{ lbs.}$$

The power required to produce this increase of speed to 60 m. p. h. will be $60^2/50^2$ or 1.4 times that required at 50 m. p. h.

The lift of an aerofoil is composed of an upward pressure on the lower surface and a partial vacuum over the upper surface which produces an upward suction. This suction is about 50% greater than the pressure on the under surface.

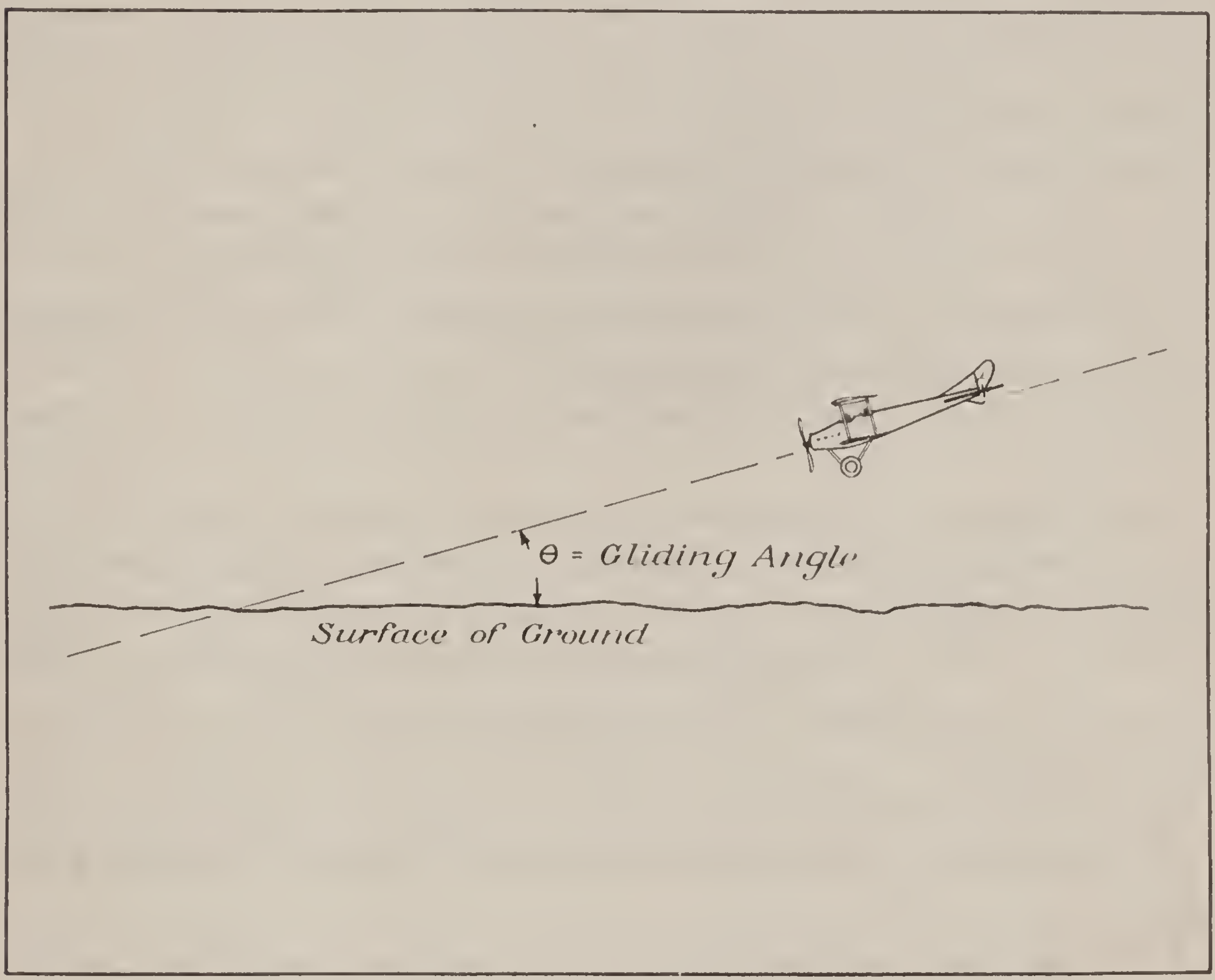
In order to produce the lift on an aerofoil a certain amount of power must be expended in overcoming the resistance opposing forward motion; this resistance is composed of the drift and surface friction. In the aeroplane there is the additional force of head resistance which is composed of the resistance of motor, fuselage, struts, wires, running gear and passengers. The sum total of these resistances is exactly balanced by the propeller thrust.

Further, every aerofoil has a critical angle beyond which the lift ceases to increase in direct proportion with an increase of angle of incidence, but on the contrary may either fall off very rapidly or remain almost constant during a further increase of the angle according to the type of aerofoil. In actual flying it is dangerous to attempt to reach this critical angle; firstly, because the lift decreases very rapidly, and secondly, because the total resistance opposing the forward motion increases in a similar proportion which has the immediate effect of slowing the machine down below its normal flying speed and thus making recovery a very difficult matter even where an excess of power is available. Ordinarily, the critical angle occurs at about 12 degrees. In practice the angle of incidence during normal flight lies between 2 and 8 degrees which leaves a very liberal margin for emergencies and for carrying extra weight.

The movement of the centre of pressure is a question which does not seriously affect the performance of the aeroplane under the ordinary conditions met with in practice. It moves toward the leading edge of the aerofoil with increase of angle of incidence and retires toward the trailing edge with increase of speed. The movement is small or almost stationary with the modern type of aerofoil.

The general behaviour of the propeller is in all essentials the same as that of an aerofoil and depends upon engine revolutions to produce the necessary thrust.

The gliding angle of an aeroplane is that angle at which it must be pointed earthwards in order to produce sufficient speed, with the power cut off, to give the necessary sustentation. It is always slightly greater than the angle of incidence during normal flight. If the steepness of the glide is increased the speed of the machine increases and vice versa. If a glide is attempted at too small an angle the aeroplane will be "stalled" in mid-air which may have a fatal result.



The force of gravity is Nature's substitute for a lack of motive power. In making "pan-cake" landings, that is, landing the machine at a very large angle compared with the normal flying angle particular care must be exercised not to reach the critical angle; the "pan-caking" should only be started when quite near the ground.

The greatest angle at which an aeroplane will climb depends upon the amount of excess power available over and above that required for normal flight and also upon the load carried. A lightly loaded aeroplane with a large excess of power will climb at a steeper angle than one heavily loaded and with a small excess of power, although the engine in the latter case may be twice as powerful as in the first case.

In actual flying the effects of momentum, inertia, and centrifugal force play a very important part.

Momentum is the quantity of motion of a moving body, that is, the product of its mass by its velocity; or, the impetus gained by movement.

Inertia is the property of a body by which it continues in its existing state of rest or uniform motion in a straight line, unless that state is changed by an external force.

Centrifugal force is the force exerted by a body while moving on a circular or curvilinear path and always acts outward from an imaginary centre of rotation.

Momentum can only be destroyed by a constant resistance which opposes motion. Such resistances are, the resistance of the air, earth and water, all of which can be usefully used to destroy momentum in their respective spheres. When momentum is destroyed the aeroplane is at rest.

Inertia is a constant force and can only be overcome by an external force.

Centrifugal force increases as the speed increases and also as the turn becomes sharper. During any turning movement the aeroplane must be banked at such an angle that the force tending to produce a ''skid'' inward, toward the centre of the turn, is as great as the centrifugal force tending to make the aeroplane ''skid'' outward.

The nature of a force is twofold; it may be a steady pressure or a blow and of these the blow causes by far the most severe strains.

For example: A weight of 50 lbs. could be indefinitely supported by the fabric of an aeroplane wing if laid quietly upon it. If, however, it is dropped on to the wing from a height of 50 feet it would go through it without much effort. The effect of vicious gusts on an aeroplane has the same effect, but naturally less severe.

AIR STRUCTURE

It is estimated that the depth of air surrounding the earth is about 50 miles. At 15 miles the barometric pressure is about 1 inch of mercury, and the temperature is probably –60 degrees F.

The greatest altitude which has been attained in a balloon is about 5½ miles, at which altitude the barometer reads about 10 inches and the thermometer between –20 degrees F. and –60 degrees F.

The aeroplane has reached approximately 26000 feet.

The average aviator can reach 10000 feet with a little practice, without requiring extra oxygen. Flying at this altitude is sometimes troublesome and the temperature may be between 29 degrees F and 0 degrees F. Even in summer the temperature is very low.

This low temperature in the upper air stratae is partly produced by the warm air rising into the less dense air where it expands. During this process of expansion the temperature falls rapidly. On the other hand when the heavier cold air descends it is slightly compressed and in consequence is slightly warmed.

The Föhn wind in the Alpine valleys is known to rise 1 degree for every 200 feet of its descent to the valleys.

At 10000 feet the barometric pressure is about 20½ inches, and this means that the aviator can only take in about 2/3 the weight of oxygen during every breath as is possible at the earth's surface. Nature compensates for this, by making the lungs work faster.

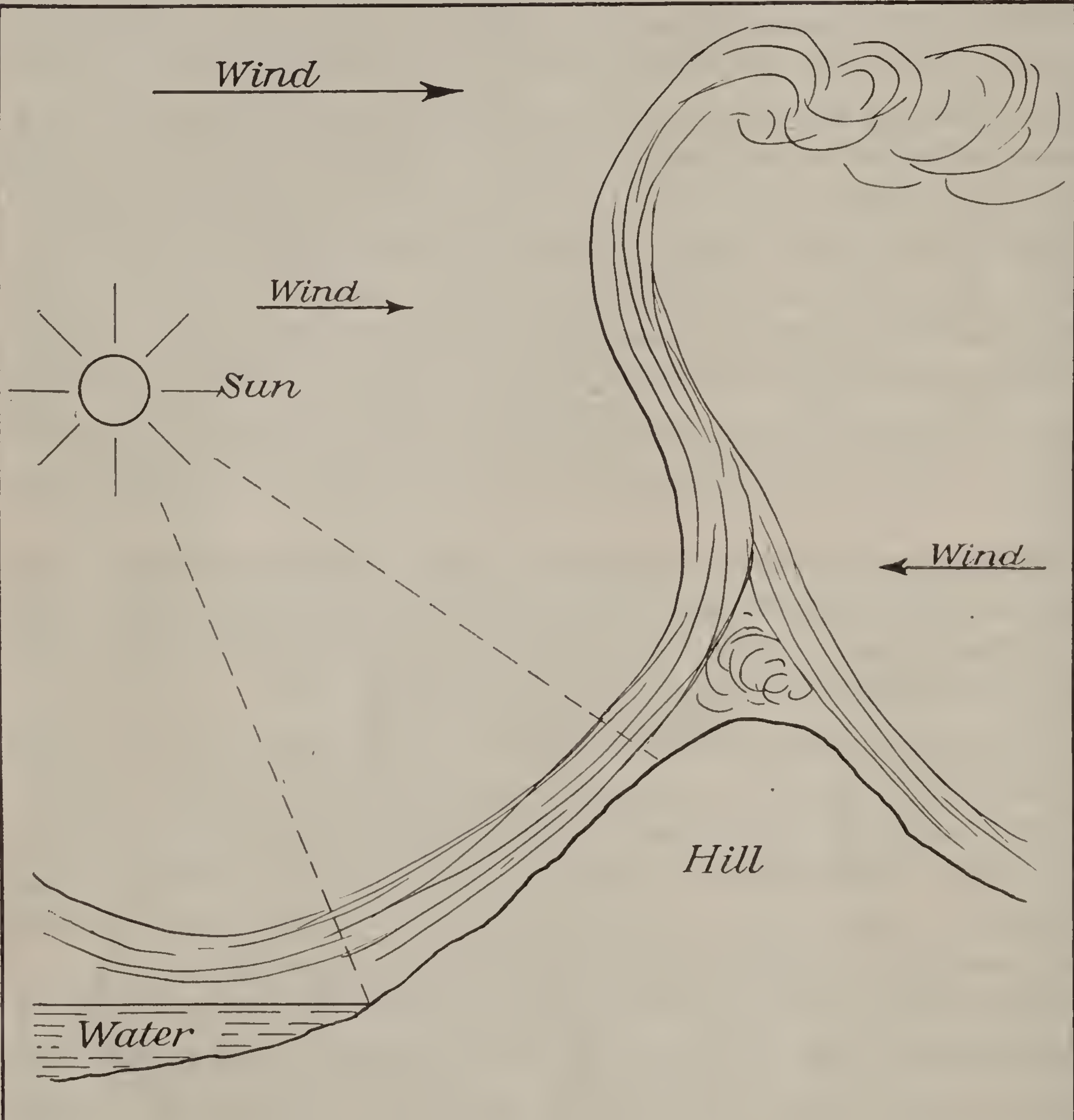
On days when the barometer is high and the air dry, it is found that the motor runs better and the aeroplane flies with greater buoyancy. This fact is of minor importance in the case of a machine with an ample reserve of power.

By far the most important effects are produced by the irregularities in the strength and in the direction of the wind. An absolutely evenly flowing wind is occasionally found over the sea at a height of 100 to 200 feet and also in the upper reaches of the atmosphere over land. A fairly steadily flowing wind is also found over large tracts of flat country at low altitudes.

Ordinarily a steady wind at the earth's surface is found to approximately double its strength at an altitude of 400 to 500 feet.

At certain times of the year, generally during late spring and autumn, two cloud layers may be seen going in almost opposite directions or even crossing at right angles, whiles the surface wind has a different direction according to the nature of the obstructions affecting its course. At the point where these different air currents pass each other there is always a region of rough air composed of eddies or waves. These waves may measure as much as half a mile from crest to crest. Cross currents, however, exist more or less throughout the year, only they are not so noticeable as at the periods just mentioned.

The unevenness of the air in the lower stratae is chiefly caused by the breaking up of the wind by hills, high buildings and similar obstructions, causing disturbances in their neighborhood, which sometimes are met at a considerable height depending upon the strength and direction of the wind. The uneven heating of the air over different kinds of landscape has a further disturbing influence. Irregularities in the flow of air near the ground is



Air Currents
and
Cloud Formation

caused by the hills and valleys which distort the wind from its average course; this distortion may be as much as 20% from the mean direction.

Generally speaking, it is found that the air has a tendency to flow downward immediately over green vegetable matter and water and to rise over bare or ploughed ground or ground covered by dry, parched vegetable matter. The extent and fierceness of these upward and downward currents depends upon the angle at which the sun's rays strike the surfaces producing these currents. If the rays strike perpendicularly the heating effect is a maximum and under this condition, upward currents of 20 m. p. h. have been met over bare ground and bare hill sides. These currents may extend over a considerable area or they may be local. Where upward or downward currents exist, turbulent air is invariably present where these currents pass through stiller air or where they pass currents going in the opposite direction. These vertical currents are bent and deflected by the horizontal currents according to their strength and direction.

In mountainous country it is found that there are generally descending currents on the shaded slopes and ascending currents on the sunny slopes. The direction of these currents is modified by the surface wind prevailing at the time and by the nature of the surface of the slopes themselves. When the sun heats moist masses of air, violent eddies are set up which rise and become gradually destroyed or condensed as they reach the colder upper air, where they appear as clouds. In summer these clouds generally take the form of thunder clouds and are produced on still days when there is very little motion of the atmosphere. On days when light breezes stir the air, these clouds form just the same, but they are white and fleecy in appearance instead of dark and solid looking.

In thundery weather the air between the earth and the higher air stratae is in a very agitated state and it is very difficult to control a machine when flying through such air, as it rolls and pitches considerably and may even take vertical drops of several feet. In addition to these movements the machine will quite suddenly oscilliate rapidly sideways, the wing extremities vibrating viciously. This disturbance is probably due to an eddy of small diameter but vicious in character.

After a heavy shower the air is "straightened out" and becomes calm and remains in this condition until wind or other agencies cause further disturbances.

On mornings when the ground is covered with frost, dew or mist, there is considerable disturbance in the lower air while the sun is evaporating this moisture. The same thing happens with mist or fog over water, the disturbances in the latter case being generally more violent.

On bright, clear days considerable difficulty is experienced in climbing between or through dense cloud clusters on account of the descending currents. Descending currents are also found to some extent when flying through shadows cast by dense clouds on clear days.

During certain times in the year, the wind is found to be gusty. This pulsation of the wind is a variable quantity and may vary more than 30% from its average velocity.

In squally weather there are alternate periods of dead calm and gusts which may be of from 35 to 40 m. p. h. The weather reports would define such a wind, as a gusty wind of 20 m. p. h. Flying in such winds should only be tackeled by an experienced aviator on a good machine.

In mountainous or hilly country the aviator must be prepared to encounter very rough air. If there is wind as well as sunshine the would-be horizontal and vertical currents will have very exaggerated directions and will without fail put an aviator in a tight corner if he has not sufficient altitude to allow for emergencies. The aeroplane may be forced down as much as 1000 or 1500 feet at a time without giving the aviator any choice. At the next instance he may be carried up vertically for a like distance only to be brought down again later on. Combined with these conditions much difficulty is experienced from gusts coming out of gullies. These gusts may be fierce enough to turn the machine completely around and leave it temporarily out of control.

The only way to overcome these difficulties is to fly high enough to be out of range of such disturbances. The severity of the wind will determine the altitude at which safety may be expected. The safest way is to make a "round about" journey and avoid such country.

CROSS COUNTRY FLYING

The main difficulties in flying across country are the following:

Estimating the strength and direction of the wind and allowing for the drift.

Recognizing objects when looking at them from above and identifying unfamiliar country from the map.

Retaining the sense of direction when the earth is hidden by clouds, or when flying over large expanses of water out of sight of land, or when flying through rain, hail, clouds or snow.

Deciding quickly what portion of the panorama is suitable ground to land on in case of motor stopping.

The difficulty in allowing for drift arises from the fact that the strength and direction of the wind varies at different altitudes and over different kinds of surface. When flying against a very strong headwind at a considerable altitude it is difficult to immediately estimate whether the machine is making headway or being blown backwards. When flying with such a wind there is always danger of being carried beyond the point at which it is desired to land. The direction and force of the surface wind can be estimated from smoke, dust, clouds, the motion of trees or grass, motion of waves, flags, etc. That of the upper air can only be judged by the motion of the clouds; if there are no clouds the only way is to ascertain the drift by a trial flight.

To do this take two given points a known distance apart and in the same direction in which the cross country flight is to be made. Start from the first point and head the machine straight for the second point. In traversing this distance the machine will be drifted off its course by a certain amount. When the machine is abreast of the second point the distance drifted is estimated. The correction in degrees is then obtained from the table for correction of drift. During a long flight this correction should be checked from time to time whenever possible.

In rough stormy weather during which rain, hail and snow are encountered it is very troublesome to steer a true course. Where flights are made covering the whole day, it is well to remember that the morning wind often blows in a different direction to the evening wind.

When flying over strange country, over water out of sight of land, or through or over dense clouds the compass must absolutely be depended upon and too much importance cannot be laid on the necessity of carefully estimating the amount of drift beforehand. The recognition of different kinds of objects and different kinds of country becomes, after a little practice, almost instinctive and this is indispensable when consulting the map.

The best aviation maps are those reduced from the Ordnace Surveys and are plotted to a scale of 2 miles to 1 inch. They show roads, railroads, rivers, lakes and woods very clearly. Water is easily the best landmark and next best are the railroads. In preparing for a long flight, the time at which the aviator should be over certain places should be worked out as a check on his progress and position. In case of losing the way completely the aviator should try and pick up some known landmark and readjust his course from this. If caught in rain, snow or fog it is unsafe to land unless the location of a safe landing place is known and is within easy reach.

On clear days the extent of view obtained from an aeroplane is enormous, but in misty or rainy weather the view of the earth is almost completely cut off.

It is of prime importance that the aviator continually keeps in mind the direction of the wind and the position of possible landing places as he flies over new country. It is well to know that a machine will glide farther down wind than it will against the wind.

A good altitude for cross country work is 3000 feet. This may be considerably reduced where good landing places are abundant or when flying over water. In mountainous country it must be exceeded.

The art of making forced landings is the cross country flier's greatest asset. He should be able to land as easily in a vertical spiral as he does on the longest glide; down wind or against the wind; pancake or normal landing.

When at a safe altitude, the aviator always has time to start down on an easy circle and it is then that a complete view of the panorama can be obtained. Once having decided where to land he can adapt the glide to suit conditions.

A real difficulty exists in estimating the altitude of an aeroplane when flying over dead smooth water out of sight of land. Unless the aviator can find some points, such as floating sticks, rocks, birds or ripples on which to focus his vision, his estimate is liable to be erroneous.

It is also well to remember that rough or choppy water is very much harder to move over at speed, than rough ground. On the other hand it always offers a comparatively safe landing place.

CHOICE OF MACHINE

The choice of a machine is determined by the uses for which it is required and the speed at which it is desired to travel. The most popular aeroplanes today are the flying boat, the passenger tractor, the passenger pusher and the exhibition model.

Pilots find that they prefer to fly the same kind of machine which they have learned on, as they are more familiar with its particular behaviour. However, any well designed and soundly built aeroplane turned out by a reputable company can meet the general requirements.

Prospective purchasers should use their discretion and resist being tempted to buy low priced aeroplanes. Experience is costly, and when incorporated in a first class product, that product is entitled to its just reward.

The flying boat is essentially a water machine and is designed to carry two or more people.

The passenger tractor is primarily an army machine but can be modified to suit civilian uses.

The passenger pusher comes under the same category.

The exhibition machine forms a class of its own.

All of these models are excellent for the duties for which they are designed.

CORRECTION FOR DRIFT

For a drift of	Correction in Course
1 Mile in every 58 of journey	1 degree
1 " " " 30 " "	2 "
1 " " " 20 " "	3 "
1 " " " 14 " "	4 "
1 " " " 12 " "	5 "
1 " " " 10 " "	6 "
1 " " " 8 " "	7 "
1 " " " 7 " "	8 "
1 " " " 6 " "	9 "
1 " " " 5 " "	11 "
1 " " " 4 " "	14 "
1 " " " 3 " "	18 "
1 " " " 2 " "	27 "
1 " " " 1 " "	45 "

RADIUS OF VISION

Height in Feet	Distance of Horizon Miles
500	30 Miles
1000	42 "
2000	59¼ "
3000	72½ "
4000	83¾ "
5000	93½ "
1 Mile	96 "

RADIUS OF GLIDE

(Gliding angle 1 in 5)

Height in Feet	Distance
500	.47 Miles
1000	.95 "
2000	1.89 "
3000	2.85 "
4000	3.80 "
5000	4.95 "
1 Mile	5.00 "

ALTITUDE AND BAROMETER READING

(Reading of Barometer at Sealevel assumed to be 30″ at 15° C)

Reading of Barometer	Altitude in Feet
30	0
29	886
28	1802
27	2753
26	3739
25	4763
24	5830
23	6942
22	8103
21	9319
20	10593
19	11933
18	13346
17	14839
16	16423
15	18109
14	19911

ACCIDENTS—Their Causes and Prevention

Accidents are either caused through carelessness, recklessness, lack of information, pride or intemperance on the part of the aviator, and, to a far less degree by mechanical defects in the construction of the aeroplane.

Accidents due to the latter cause are almost nonexistent in aeroplanes of well known makes at present on the market. It must be remembered, that, for the work it is called upon to perform, an aeroplane is as strong and in many cases much stronger than the best automobiles.

The greatest number of accidents can be traced to the inability or unwillingness of pilots to profit from the experiences and mistakes of others. The best aviator is he who forsees all the possibilities of accidents and takes the precaution to guard against them. Sush a pilot may not leap immediately into fame and become idolized by the public and thus reap a cheap reward, but eventually he is recognized as a thoroughly sound flier in whom the public is ready to place confidence. As his experience increases he can easily do all the so called sensational flying without attaching an exaggerated importance to exploits.

The key to every aviator's safety is summed up in this statement: Keep within the limits of personal experience.

"A wrench was left on the planes and carried into the air, where it worked its way back over the planes and struck the propeller, breaking this and consequently throwing it out of balance. A forced landing had to be made on rough ground resulting in a general wreck."

"A mechanician had been entrusted to assemble the aeroplane and get it ready for a flight. When the aviator arrived on the field he omitted to thoroughly inspect the aeroplane and as soon as he left the ground, found that the controls were connected up in the reverse direction. A level head enabled him to land without damage."

"In foot operated controls the slipping off of one foot will cause the machine to bank instantly at a steep angle from which recovery is inpossible if near the ground. Rubber shoes are dangerous if they become oily."

"A man hanging on to the tail in order to hold the machine prior to a start, distorted the elevator so that when the machine left the ground, it flew canted over to one side."

"A bad smash was caused by too much reliance being placed in the mechanician; he left out one of the bolts anchoring the tail plane to the outriggers so that when the rudder was used it pulled the tail plane out of the outrigger socket, resulting in the aeroplane 'stalling' and side slipping which culminated in a wreck."

"In the early days of aviation machines have been broken in the air due to the wing covering being literally rotten; the result has always been fatal."

"The most unpardonable kind of accident has been caused by aviators starting on a cross-country flight with a badly running motor, in the vain hope that it would improve after it 'got going'. To start on such a flight without full power, thereby sacrificing some climbing power, and also controlability, is purely and simply suicidal.''

''Fatal accidents have in many instances been caused by doing 'stunts' on a machine which was solely intended for straight flying. Also by loading such a machine to the limit and then making a precipitate descent and a very rapid levelling out prior to landing.''

''Serious accidents have been caused by aviators trying to rise out of impossible grounds with a low powered machine.''

''Others have been due to aviators being ignorant of the nature of the air currents existing in new and unfamiliar country and trying to fly in such air with a low powered aeroplane.''

''Every one of these accidents could have been avoided had the fliers been properly and efficiently instructed.''

The following are a few of the ''tight corners'' which every aviator is bound to get into sooner or later and a word of explanation is necessary:

Side-Slip: This condition may be produced by over banking or by a stiff side gust. In either case it causes the machine to lose its sustentation and slide sideways toward the ground. Recovery to the normal flying attitude can be made by pointing the nose of the aeroplane downwards and ruddering away from the lower wing. This should only be done if there is sufficient way on the machine. In the case where there is a large excess of power the aileron on the lower wing can be slightly pulled down to accelerate the recovery.

Pulling down the aileron through a large angle on an underpowered machine which is partly ''stalled'' acts as a brake on that wing and aggravates the condition.

Recovery is also possible by putting the head of the aeroplane down and ruddering toward the lower wing; this has the effect of immediately increasing the steepness of the bank and finally converting the side-slip into a nose dive from which recovery is easily made by gently pulling up the elevator. In all of these methods a considerable loss of altitude is unavoidable, and therefore aviators must never allow their aeroplanes to side-slip near the ground.

Different kinds of machines act in different ways during a side-slips. The rules just given, however, hold good for all standard aeroplanes.

In very aggravated cases of side-slip it must be realized that the elevator takes the place of the rudder during normal flight and the rudder that of the elevator, so that considered from the normal flight attitude the functions of these two elements are interchanged.

If on the other hand the aviator assumes that he is ALWAYS in the normal attitude of flight, no matter what position the aeroplane may be in, then the controls work in their usual capacities in order to produce the required results. The latter attitude is the one to be cultivated, for then the process of reasoning is not hampered by having to think from a new standpoint.

Stalling: If a machine is stalled near the ground a serious smash is bound to be the result.

If stalled in mid air by a gust or by bad piloting, there is always the same chance of recovery as with a side-slip. A machine with a lifting tail, such as the propeller type, will first slide backwards tail first for a short distance, side-slip about as far again and then dive head foremost. An aviator is comparatively safe at an altitude of 300 feet or over in a lightly loaded machine.

The tractor type of machine when stalled slides a short way backwards and then side-slips and dives. Recovery is made as from a side-slip. One thing must be remembered when a machine is stalled, namely, that there is not enough way on it for the controls to have any effect.

Capsizing: An aeroplane may be capsized and left in any old position either by a "whirl wind" or by a very stiff gust. Under such conditions an aviator's greatest safety lies in being safely strapped to his machine and retaining his presence of mind. The first thing to do is to always get the head of the aeroplane pointed downward; from this attitude recovery can be made to the normal flying attitude.

There are instances on record where aeroplanes have been turned upside down, end for end, tipped up side ways, driven nose downward and stalled and in each instance the aviators have suffered little or no injury. And here it is to be noted, that there is no danger in mid-air when an aeroplane is thrown out of its normal flying attitude, provided that the pilot is strapped in and retains his presence of mind. The only danger exists when a pilot loses control near the ground. M. Pegoud has conclusively demonstrated that it is possible in any well designed aeroplane to recover from any possible position, provided that there is sufficient altitude.

Turning: When turning from an upwind to a downward direction the machine may have to accelerate from a velocity of zero, with regard to the ground, to a velocity of twice the normal speed of the aeroplane. During the turn the inertia of the machine must be overcome and the rate of overcoming this depends upon the power and the total weight of the aeroplane. Therefore the first part of the turn must be commenced in a downward direction with full power on and when there is enough way on the machine the actual turning can be commenced; the rate of turning can be increased as the inertia is overcome. In this manoeuvre loss of altitude is inevitable and must be allowed for. The sharper the turn, the greater must be the loss of altitude.

When turning from downward to an upward direction, altitude is gained.

Either of these manoeuvres must be initiated slowly. In the first case inertia must be overcome; in the second momentum must be destroyed. Sharp turns should not be attempted on an underpowered aeroplane, especially sharp upward turns as this manoeuvre will result in "stalling" and end in a "slide-slip."

Breakage: In the past there have been instances of portions of the wings breaking in mid-air but holding together sufficiently to carry the load. Under such conditions the only thing to do is to glide to earth at as small an angle as possible and avoid all abrupt controlling movement. This manoeuvre is chiefly a war manoeuvre; in civilian flying there is no excuse for breakage in the air if ordinary precautions are taken. Two DONT'S which are violated by inexperienced pilots are: Don't ever fly a machine with insecurely fastened, rotted or torn wing fabric. Don't ever fly with a cracked or unbalanced propeller or one on which the metal tips are loose. The strains set up by an unbalanced propeller can be severe enough to tear a motor clean out of the fuselage.

Fire: This can generally be traced to carelessness or foolhardiness on the part of aviators. The necessary precautions consist in having all unions and valves "locked" throughout the gasoline system.

In event of a valve breaking in the motor, followed by backfiring through the carburetor, switch off immediately and descend. If at any time a forced landing must be made on rough ground and a smash is imminent, do not fail to switch off the motor before reaching the ground.

Forced Landings: Cross-country fliers must be able to make forced landings anywhere under any given conditions.

The most valuable manoeuvre is the spiral glide, as during the first two circles the whole landscape can be observed and the best landing place chosen. It is a manoeuvre which must be learned progressively and should never be attempted by novices. Proceed as follows: After right and left hand turns can be made with confidence these can gradually be turned into downward turns while keeping the motor running. At first, half circles should be attempted and the manoeuvre thought over after each attempt. Gradually full turns can be made and then the "banking" increased. The steepest spiral possible is made in a circle of roughly twice the span of the aeroplane and should be attempted only by aviators of ripened experience. Much more gradual spirals are sufficient to meet any emergency of a forced landing.

To initiate a steep spiral on a propeller machine proceed as follows: Head steeply downward simultaneously banking the right wing up steeply by the ailerons. Immediately bring ailerons to normal and rudder toward the left wing which will increase the bank. Then almost instantly pull the elevator up which now acts as the rudder, and the spiral is in progress. (Refer to previous remarks on rudder and elevator.) All these movements must be made smoothly and consecutively and not abruptly, with the motor switched off. During these evolutions the rudder is very sensitive as well as the other controls and the pilot should always feel that he is master of the machine and never let it get out of control. During such a spiral the aeroplane drops at from 100 to 120 m. p. h., and good judgment must be used in landing.

When landing on ploughed ground, if possible, always land parallel to the furrows and "pancake" if necessary. On rough or muddy ground, sand soil or fields of wheat, etc., always "pancake" and pick the furrows if possible. If forced to land on top of a forest, pick a good dense cluster of trees and "pancake" so that the last 10 feet is a vertical drop.

If a forced landing is made in water with a land machine, try and reach the shore and then "pancake" into the water a few feet from land. If out of reach of land the machine will float for a considerable time if neatly "pancaked".

All landings in windy weather should always be made at a good speed and against the wind, if possible under power.

Stopping: If a landing has been made in a small space and the speed of the machine is insufficiently checked so that there is danger of a collision, it may be considerably slowed by depressing the tail fully so that the rear end of the skids dig into the ground.

If there is not room for this, put the ailerons and rudder hard over for a sharp turn at the same time pulling up the elevator. If the speed of the machine is such that the controls have lost the greater part of their effect, full power can be switched on to help the machine around and here the greatest care and discretion must be used and the motor switched off immediately if it is not producing the required effect. This is a very drastic manoeuvre and culminates in some breakage, generally to the running gear.

Straps: The chief occasion on which straps are of service is when flying in gusty and treacherous weather in either a tractor or a propeller type of machine. It is generally thought safer to remain strapped in when flying a tractor and only to use the straps during flight on a propeller machine. In the latter case the pilot is better off if thrown clear of the machine in case of a smash.

Thomas